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In an attempt to dispel this undeserved reputation and gain operating experience for application of automation to new shipboard HF systems, an HF radio communications system incorporating automatic link establishment (ALE), single-tone serial modems and 500-watt transceivers was deployed on USS TARAWA (LHA-1) and to serving Navy shore communications stations during her recent deployment to the Indian Ocean and Persian Gulf. This paper describes the use of this system for bidirectional 600 baud message traffic.

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The Operational Use Of An Automated High Frequency Radio System Incorporating Automatic Link Establishment and Single-Tone Serial Modem Technology for U.S. Navy Ship-Shore Communications

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ABSTRACT The U.S. Navy has all but ceased to use high frequency (HF) radio for long-haul ship-shore communications. Satellite systems have rightfully assumed this role, but the antiquated nature of the Navy HF system has soured planners on even considering HF for supplementary uses or other roles.

In an attempt to dispel this undeserved reputation and gain operating experience for application of automation to new shipboard HF systems, an HF radio communications system incorporating automatic link establishment (ALE), single-tone serial modems and 500-watt transceivers was deployed on USS TARAWA (LHA-1) and to serving Navy shore communications stations during her recent deployment to the Indian Ocean and Persian Gulf. This paper describes the use of this system for bidirectional 600 baud message traffic. This is first application of the combination of MIL-STD-188-141A [1] ALE and MIL-STD-188-100A [2] single-tone serial modem technology in a U.S. Navy operational environment.

The ALE radio system was used to automatically test and select the best channel from among several assigned frequencies and establish a link between ship and shore. Accumulated message traffic was then passed over the single-tone serial modem to the distant end.

Technical details of the installation and operational techniques are presented along with a discussion of how automation greatly reduced the level of skill and experience needed to successfully operate this HF system. Test results are presented which illustrate the success enjoyed in maintaining communications over paths which had long been considered unworkable with existing shipboard HF equipment and techniques. The potential for application of automated HF to short-range over-the-horizon (OTH) communications needs for littoral warfare is also discussed.

INTRODUCTION Although UHF and SHF satellite systems are the primary means for maintaining ship-shore communications, some parts of the world do not have sufficient satellite coverage to satisfy all communications needs. Additionally, because of the rapid change in Navy mission areas since the end of the Cold War, amphibious forces have been thrust to the front and are now covering contingencies which require communications support in excess of their normal capabilities. As a result, some amphibious readiness groups (ARG's) have been deploying with "strap-down" SHF satellite communications (SATCOM) systems which are cross-decked from returning ships to deploying ships in order to serve these extra needs (older LPH class ships have been using "strapdown" SHF systems; LHA and LHD classes have received permanent SHF installations). In anticipation of such a deployment, NCCOSC RDTE DIV was offered an opportunity to demonstrate the feasibility of using current state-of-art HF radio technology to satisfy this long-haul ship-shore communications need.

BACKGROUND As a result of familiarity with our previous HF work, we were approached by the staff communicator of Commander, Amphibious Squadron Five (COMPHIBRON FIVE) for help in significantly improving their HF communications for an upcoming deployment. The system we proposed would be installed onboard USS OKINAWA (LPH-3) for use during her deployment into the U.S. Central Command area of responsibility (CENTCOM AOR) in the Indian Ocean and Persian Gulf. This area is marginal for UHF SATCOM coverage, and at that time the staff was unsure whether they would receive an SHF satcom "strap-down" system. The OKINAWA's existing HF system used 1960's frequency shift keying (FSK) technology which had proven very marginal over the paths involved. As a result of delays in funding, the system we proposed missed the OKINAWA and instead was deployed on USS TARAWA (LHA-1) for use during her later deployment into the same area.

APPROACH The method proposed to fulfill this HF communication need was a combination of a state-of-the-art HF ALE radio system and a state-of-the-art signal processing single-tone serial modem. Each radio system consisted of a fully automatic microprocessor-controlled 500-watt radio transceiver incorporating the ALE control protocols and waveform specified in MIL-STD-188-141A. The radio system block diagrams for the ship and shore ends are shown in Figures 1 and 2, respectively. The specific equipments are from the Harris RF-350 family and were previously used in a related sounder experiment conducted in the Mediterranean Sea in 1990 [3]. Actual record traffic was passed at 600 baud via Harris Model 5254C modems which were interfaced to KG-84C encryption devices and standard data terminal equipments. Laptop PC's provided automatic logging of system activity and served as uncovered terminals for operator-to-operator (OTO) coordination notes sent using the data text message (DTM) feature of the ALE standard.

We were confident that the ability of the ALE system to find and establish a channel automatically would prove to be the most attractive feature of the system. This would eliminate the cumbersome process of estimating propagation and manually coordinating frequency shifts by means of a separate orderwire link with the shore end.

In the course of her full six-month deployment, TARAWA would be served from three shore communications establishments. Initial installations were made at the stations on Hawaii and Guam. As the TARAWA headed west, the Hawaii installation was removed and reinstalled on Diego Garcia in the Indian Ocean.

OBJECTIVE The overall objective of this task was to demonstrate that modern technology could be used to make HF a viable, easy to use medium for ship-shore communications, and that excellent long-haul performance could be obtained with relatively low-power inexpensive radio equipment. More specific objectives were as follows:

A. Demonstrate that the "on-call" ability of ALE to quickly establish a circuit when needed could satisfactorily replace the 24 hour-a-day full period termination normally used to provide HF connectivity with existing manual systems.

B. Demonstrate that the level of automation provided by ALE would substantially reduce the labor and skill required to maintain ship-shore HF communications.

C. Attempt to determine the correlation between the link quality analysis (LQA) score measured by ALE and single-tone serial modem performance.

D. Gain experience in HF ALE system operation from the Navy operator's viewpoint.

PROCEDURES With conventional manual systems, U.S. Navy ships attempt to maintain a continuous full duplex HF "full-period termination" with their serving shore station so that message traffic could be passed as required. This method is very labor intensive but was considered necessary in order to provide full backup for SATCOM systems. The cessation of the Cold War and contracting defense budgets have forced relaxation of the requirement for maintaining these HF terminations, and they are now provided only upon request, and usually only in locations with limited SATCOM coverage.

The HF ALE system allows the operator to quickly establish a link with the serving shore site (propagation permitting), pass traffic and terminate the link; all with minimal labor. This ability to "place a call" when needed eliminates the necessity for continuously maintaining a termination just in case some traffic might need to be passed. With this in mind, operators on each end were invited to use the HF ALE system to the extent they found practicable. The TARAWA Communications Officer indicated that he intended to use the HF ALE system to pass all category 4 (routine) message traffic, and would pass additional traffic depending on system/circuit reliability. The test was conducted over the period 28 May through 07 November 1992.

RESULTS The HF ALE system deployed on USS TARAWA proved to be an extremely reliable and effective communications system. Procedural and hardware start-up problems yielded mixed results during the Eastern and Western Pacific portions of the deployment. From mid-July through mid-October, TARAWA maintained her HF ALE termination with the Naval Computer and Telecommunications Station (NAVCOMTELSTA) on Diego Garcia in the Indian Ocean. Once hardware siting problems were resolved, the system worked extremely well. The system was used to pass virtually all ship-shore traffic during this period, and the DTM feature was used to pass numerous OTO's not only for HF ALE, but also in support of the other TARAWA communications systems. With ALE automation performing the difficult task of finding, establishing and maintaining decent HF channels, the TARAWA communications supervisors quickly determined that junior, inexperienced personnel could be easily trained to run the HF ALE system. The powerful signal processing performed by the single-tone serial modem yielded virtually error-free reception of narrative message traffic. Thus HF was transformed from a difficult, unresponsive medium into a very viable communications channel. Detailed results are reported chronologically in the following sections.

A. EASTERN PACIFIC. The TARAWA maintained her communications with the Naval Computer and Telecommunications Area Master Station, Eastern Pacific (NCTAMS EASTPAC) located in Hawaii from 28 May through 15 June 1992. Results on the HF ALE system were generally satisfactory with a 150 messages being passed. The major difficulties encountered were procedural, involving record keeping problems and returning the shore terminal equipment to service after maintenance.

Experiments were performed during this time in an attempt to characterize system performance. Of interest was the correlation between the single-tone serial modem bit error rate (BER) over the HF channel, and the channel quality figure derived by the ALE system when the channel was established. The ALE data words exchanged by the controllers when a channel is established include bits which are examined for errors at both receiving ends in turn and are used to calculate a combined link quality analysis

(LQA) score. The LQA score is displayed to the operator as a number on an arbitrary scale of 0 to 120, with a score of 120 indicating an excellent bidirectional channel. The LQA measurement period is very short, thus scores on the same channel can vary significantly from minute to minute if significant fading is present.

Our test was conducted between message delivery events on a single day, and consisted of the transmission of 2700 character test messages. We found that these test messages could be passed error free over channels with LQA scores in the 60-120 range. Voice communications became difficult on channels with LQA scores below about 75. From an operational standpoint, the very steep BER vs signal-to-noise-ratio (SNR) curves of the single tone serial modem [4] generally mean that you either pass traffic error free, or not at all. On the marginal channels, deep fading typically resulted in the system losing synchronization and thus remaining portions of test messages were lost.

B. WESTERN PACIFIC. The TARAWA maintained her communications with the Naval Computer and Telecommunications Area Master Station, Western Pacific (NCTAMS WESTPAC) located on Guam from 15 June through 17 July 1992. As a result of an intermittent hardware problem in the RF-7210 ALE controller, this portion of the test was very unsatisfactory. Though ALE operation was erratic, it functioned enough times to demonstrate that the system was wired correctly and probably would have worked if this problem were not present. The NCTAMS WESTPAC operators put a lot of time attempting to troubleshoot the problem, but lack of on-site spares prevented timely resolution.

An additional problem occurred aboard TARAWA with caused the AN/UGC-143V(4) Navy Standard Teletype (NST) to fault out due to failure to receive a clear-to-send (CTS) response to a request-to-send (RTS) command in a timely fashion. This appeared to be due to having the Harris RF-5254C HF serial modem set to operate as a half-duplex device instead of full duplex. In the half-duplex mode, the RF-5254C modem must receive an end-of-message bit sequence from the transmitting station before it will respond to a local transmit RTS command. If this is not received, the modem hangs in receive for 12 seconds before it times out and is enabled to respond to transmit commands. Setting the RF-5254C internal programming switches to the full-duplex position (even though the radio is a half-duplex device) eliminated this problem.

C. INDIAN OCEAN AND PERSIAN GULF. The TARAWA maintained her communications with the Naval Computer and Telecommunications Station on Diego Garcia (NAVCOMTELSTA DIEGO GARCIA) from 18 July through 15 October 1992. Even though Diego Garcia is 11 time zones and 50-60 hours of en route time away, the NCCOSC RDTE DIV installation team accomplished the installation as planned without incident. Initial operation was marginal due to operation of our HF transceiver collocated with 25 HF transmitters. Eighteen of these 25 transmitters were operating in the 20-30 MHz band, which was unfortunately the band of best propagation to TARAWA. The result was that our receiver was clobbered by EMI from the other transmitters.

An attempt was made to fix this problem by establishing a split-site operation using a station R-2368/URR in place of the receiver portion of our transceiver. The station receivers are located near the technical control area, thus it was feasible to simply run a cable from the Harris RF-7210 ALE controller to the receiver. This was not successful because we were unable to gain control of the receiver via the remote interface. Later investigation revealed that the appropriate switch setting table in the R-2368 receiver technical manual had been erroneously inverted.

The EMI problem was finally overcome by moving the radio suite to a location where it could be used with a broadband inverted cone antenna located near the receiver site. This worked extremely well, and the system was used satisfactorily for the remainder of TARAWA's deployment in that area.

During the month of August 1992, TARAWA was on station in the Persian Gulf, an area where summertime long haul HF using standard (but archaic) voice frequency carrier telegraph (VFCT) equipment has long been considered unworkable. This time however, the powerful signal processing capabilities of the ALE and single-tone serial modems was able to deliver almost round-the-clock 600 baud service with ease.

Table 1 shows the weekly utilization of the HF ALE system during this period, with the data being derived from a performance summary provided to TARAWA from NAVCOMTELSTA Diego Garcia. As a result of the interest of the TARAWA communications supervisors, virtually all of their ship-shore traffic was directed into the HF ALE system. The embarked flag (COMPHIBRON ONE) communications was passed via satellite as was some high precedence traffic. As a result of typhoon damage to NCTAMS WESTPAC facilities in Guam, satellite traffic was rerouted for a period of time via a complex route to facilities in Europe for the uplink to the SHF satellite. On a few occasions both the SHF and UHF satellite coverage went down for short periods of time, which left our HF ALE system as the sole ship-shore link.

Table 2 shows HF ALE system utilization for selected days for which position data was available for TARAWA. The plotted track for these positions is shown in Figure 3. Note that the operating range was generally in excess of 2000 nautical miles (3656 KM).

The USS OKINAWA, the ship originally intended as the HF ALE test platform, deployed into the same operating areas as the TARAWA, departing San Diego in early January 1992. Though she didn't carry the HF ALE system, she did deploy with a Harris RF-5254C modem and teletype essentially identical to the arrangement we installed on TARAWA. This suite of equipment was connected into her existing conventional HF radio system and thus provides a very crude comparison performance with and without ALE. Table 3 shows HF utilization data for the period during which OKINAWA ran an HF termination with NAVCOMTELSTA Diego Garcia. OKINAWA carries a UHF SATCOM system, but did not deploy with the additional SHF system that TARAWA carried; thus her HF message traffic count is somewhat higher that TARAWA's. The high traffic volume and high availability figures are testimony to the processing power of the single-tone serial modem and the dedicated professionalism of both the OKINAWA and NAVCOMTELSTA Diego Garcia operators. The comparative value of Table 3 is clouded by the significant differences in operating conditions, which are largely undefined (i.e., antennas, power levels, different seasons for propagation, noise, etc.).

The manual operation of an HF ship-shore termination is very labor intensive and requires fairly skilled operators to coordinate and manage frequency changes, tune transmitters, receivers and multicouplers, and correct circuit problems. Thus while the data shown in Tables 1 and 3 don't show much difference in terms of "bottom line" results, TARAWA obtained hers with less manpower, using junior, inexperienced personnel instead of the senior, skilled operators normally required. This advantage is the result of the automation introduced with the HF ALE system.

One other observation concerns the PROPHET [5] frequency prediction program which is used by the Fleet to choose frequency assignments. The predictions we produced prior to deployment indicated that we would probably not communicate at all when TARAWA was in the Persian Gulf. These predictions were re-examined in light of our actual experience, and confirmed what had been observed in a study done as part of a master's thesis [6], which basically found that PROPHET is overly pessimistic in its predictions.

<u>CONCLUSIONS</u> The combination of the HF ALE radio system and the single-tone serial modem offer an extremely cost effective method for utilizing the HF medium for long haul delivery of ship-shore narrative message traffic.

The waveforms and associated coding and signal processing used in the ALE equipment and in the single-tone serial modem provide substantial improvement over the antiquated FSK technology which is still the U.S. Navy standard.

The automation in radio operation provided by the ALE standard as implemented in the Harris RF-7210 controller provides a substantial reduction in the skill and experience required to successfully operate a ship-shore HF termination. It also eliminates the need for extra people to run radio equipment and also the need for separate orderwire circuits for coordination. The reduction in personnel involved also minimizes the opportunity for making errors, thus further improving communications effectiveness.

With the reorientation of the primary Navy mission towards littoral warfare [7], the need for improved ship-to-landing force communications becomes critical. Once beyond line-of-sight, only satellite and HF communications can be used from ship to shore or between units separated by rugged terrain. The Marine Corps has long used VHF relay as a communications method, but in a rapidly moving situation, especially if rugged terrain is part of the environment, the near vertical incidence skywave (NVIS) mode of HF propagation, and mobile satellite communications devices may be the only method of communications which are satisfactory.

The AN/PRC-104 manpack and AN/GRC-193 vehicular HF transceivers are fairly modern and easy to operate, but provide only conventional single sideband (SSB) operation. Marine Corps radio operators are still faced with all the problems and difficulties associated with manual establishment and maintenance of HF communications channels. Senior Marine Corps communications planners have expressed their concern over the viability of HF, especially for critical roles such as off-shore gunfire support. ALE and modern modem would certainly do a fair amount to improve this situation.

<u>RECOMMENDATIONS</u> High frequency radio communications will never provide the bandwidth and low error rate of which satellite systems are capable. With modern enhancements such as ALE and the single-tone serial modem, HF can be used as a highly cost effective and flexible means of communication as was demonstrated in the TARAWA test. In pursuit of more effective use of HF for communications, we recommend the following:

A. Conduct expanded testing and demonstration of application of HF ALE for multi-user nets, including transfer of computer files and data other than narrative message traffic. This should include communications in amphibious ship-shore situations in which ALE and better modems are applied to both manpack and vehicular HF systems and situations. It is necessary to provide Navy and Marine Corps communications planners a feel for the utility of HF in serving communications needs with currently available state-of-the-art equipment.

B. Establish regular coordination and cooperation with other services and federal agencies with regard to development and promulgation of HF standards. This will insure that Navy and Marine Corps concerns and needs are addressed.

C. Establish an operational requirement (OR) for use of HF ALE, as embodied in the TARAWA test, to serve as a supplemental communications method for ships deploying into areas such as the CENTCOM AOR. It is feasible to develop a "strap-down" system for temporary installations much like the modem-teletype system placed aboard OKINAWA.

D. In the coming years, military budget limitations and changing Navy missions may drive the use of modern HF systems to fulfill communications needs where a satellite solution is just too expensive. Planning for the future of HF should include an alternative covering just such a scenario to insure that this need can be addressed should it arise.

ACKNOWLEDGEMENTS This work was performed at the request of the Commander, Space and Naval Warfare Systems Command, PMW 152. Special thanks go to CWO Bill Helmich, who as Communications Officer of COMPHIBRON FIVE offered the opening opportunity which led to the TARAWA HF ALE test. Special thanks also to the men of the Communications Department of USS TARAWA, the operators at NCTAMS EASTPAC, NCTAMS WESTPAC and NAVCOMTELSTA DIEGO GARCIA, whose interest and enthusiasm made the HF ALE test a great success.

NOTES/REFERENCES

[1] MIL-STD-188-141A Military Standard, Interoperability and Performance Standard for Medium and High Frequency Radio Equipment. Sept 1988

[2] MIL-STD-188-110A Military Standard, Interoperabilty and Performance Standards for Data Modems. Sept 1991

[3] Francis, G.P. Automatic Link Establishment (ALE) System for Sea-Based High Frequency Sounder; Demonstration and Test. Technical Report TR-1364, Naval Ocean Systems Center, Sept 1990

[4] McRae, D.D. and LeFever, R.S. Results of HF Modem Link Tests Between Cape Canaveral, Florida and Antiqua, West Indies. ATD Technical Report 56, Harris Corporation, 1984

[5] PROPHET is a computer program developed at the Naval Ocean Systems Center (now NCCOSC RDTE DIV) to permit predictive assessment of HF propagation and provide other communications decision aids. PROPHET was first deployed in 1976 and the current version usable on MSDOS PC's is PROPHET 3.2.

[6] Giakoumakis, G.H., A study of PC-Based HF Ionospheric Propagation Predictions for use in Naval Communications, Master's Thesis, U.S. Naval Postgraduate School, Monterey, CA. June 1990

[7] ...From The Sea, Preparing the Naval Service for the 21st Century Navy and Marine Corps White Paper. Sept 1992.

TABLE 1
HF ALE COMMUNICATIONS SYSTEM UTILIZATION 1
USS TARAWA TERMINATED WITH NAVCOMTELSTA DIEGO GARCIA

DATE	MSGS SENT BY TARAWA #	MSGS RCVD BY TARAWA #	MAX MSGS IN ONE DAY #	MIN CKT AVAILABILITY 2 TAR. SND %	MIN CKT AVAILABILITY 2 TAR. RCV %	AVG CKT AVAILABILITY 2 TAR. SND %	AVG CKT AVAILABILITY 2 TAR. RCV %
JULY							
18–24	203	608	168	99	75	99	96
25–31	35	63	52	100	100	100	100
(NOTE: IN PORT BAHRAIN 26–30 JUL)							
AUGUST							
01–07	167	376	126	24	95	80	99
08–14	185	370	132	56	95	80	99
15–21	223	511	163	60	74	80	94
22–28	151	429	161	43	66	83	94
29–04 SEP	146	100	66	77	100	89	100
SEPTEMBER							
05–11	156	398	140	67	84	87	97
12–18	107	821	237	27	100	83	100
19–25	157	17	33	66	100	88	100
26–02 OCT	111	350	157	11	100	67	100
OCTOBER							
03–09	319	529	189	57	58	89	94
10–16	49	223	100	72	94	91	96
(NOTE: IN PORT PERTH 11–13 OCT)							
27–05 NOV	72	514	(SEE NOTE 3)				

NOTES:

1. Per TARAWA operators, virtually all of their ship–shore message traffic was sent via the HF ALE system, thus numbers represent typical traffic loading.
2. Circuit availability includes terminal equipment as well as radio equipment. Per TARAWA operators, almost all the down–time resulted from the MARCEMP shore terminal program crashes. No further breakdown attributing down time to specific portions of the HF ALE system is available.
3. These are total figures for special period of long–range testing. Maximum daily total and availability numbers were not provided.

TABLE 2

HF ALE COMMUNICATIONS SYSTEM UTILIZATION 1

SELECTED DATES FOR WHICH RANGE DATA IS AVAILABLE

USS TARAWA TERMINATED WITH NAVCOMTELSTA DIEGO GARCIA

DATE	MSGS SENT FROM TARAWA	MSGS RCVD BY TARAWA	RANGE IN NAUT MI	RANGE IN KM
18 JUL 92	12	156	1149	2100
20 JUL 92	59	54	1457	2663
25 JUL 92	6	40	2408	4403
31 JUL 92	29	23	2408	4403
05 AUG 92	28	73	2648	4841
16 AUG 92	31	132	2648	4841
20 AUG 92	20	101	2526	4618
25 AUG 92	15	79	2407	4401
30 AUG 92	20	1	2573	4704
05 SEP 92	7	1	2565	4689
10 SEP 92	4	136	2340	4095
21 SEP 92	30	1	1707	3121
25 SEP 92	16	0	1720	3144
30 SEP 92	28	2	1324	2421
05 OCT 92	39	44	373	681
10 OCT 92	27	73	2238	4092
15 OCT 92	9	58	2838	5188
05 NOV 92	(SEE NOTE 2)		4500	8227

NOTES:

1. Per TARAWA operators, virtually all of their ship–shore message traffic was sent via the HF ALE system, thus numbers listed represent typical traffic loading. Our worst case estimate for system capacity at 600 baud is about 700–1000 messages per day, based on 36,000 bit messages (one full page), and data actually being sent about half of the day.
2. Utilization figures not available. TARAWA reports this as range at which message traffic last successfully exchanged with DGAR.

TABLE 3

HF ALE COMMUNICATIONS SYSTEM UTILIZATION 1

USS OKINAWA TERMINATED WITH NAVCOMTELSTA DIEGO GARCIA

DATE	MSGS SENT BY OKINAWA #	MSGS RCVD BY OKINAWA #	MAX MSGS IN ONE DAY #	MIN CKT AVAILABILITY 2 OK SND %	MIN CKT AVAILABILITY 2 OK RCV %	AVG CKT AVAILABILITY 2 OK SND %	AVG CKT AVAILABILITY 2 OK RCV %
FEB							
10–16	201	824	279	84	80	98	97
17–23	327	875	306	100	100	100	100
24–01 MAR	434	1098	380	100	66	100	95
MARCH							
02–08	311	655	222	100	97	100	99
09–25	244	546	245	100	97	100	99
(NOTE: IN PORT 13–24 MAR; 09–25 MAR INCLUDES 7 ON–AIR DAYS)							
26–01 APR	254	1357	434	100	100	100	100
APRIL							
02–11	182	961	214	100	100	100	100
(NOTE: IN PORT 04–06 APR; 01–11 APR INCLUDES 7 ON–AIR DAYS)							
12–18	244	709	177	86	81	95	91
19–30	127	420	160	55	84	80	96

NOTES:

1. The USS OKINAWA deployed into the Indian Ocean and Persian Gulf operating areas with the Harris RF–5254C modem and AN/UGC–143V(4) teletype, but used their existing HF radio equipment.
2. Circuit availability includes terminal equipment as well as radio equipment. Data providing a breakdown of cause of outages is not available.

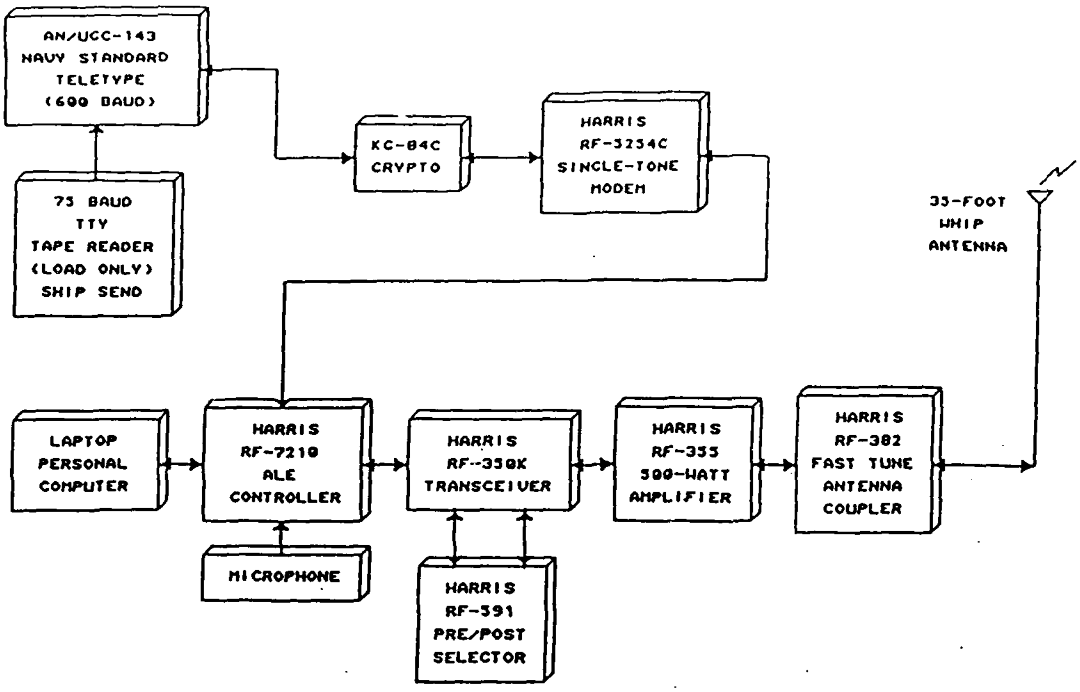


FIGURE 1. USS TARAWA HF ALE SYSTEM BLOCK DIAGRAM

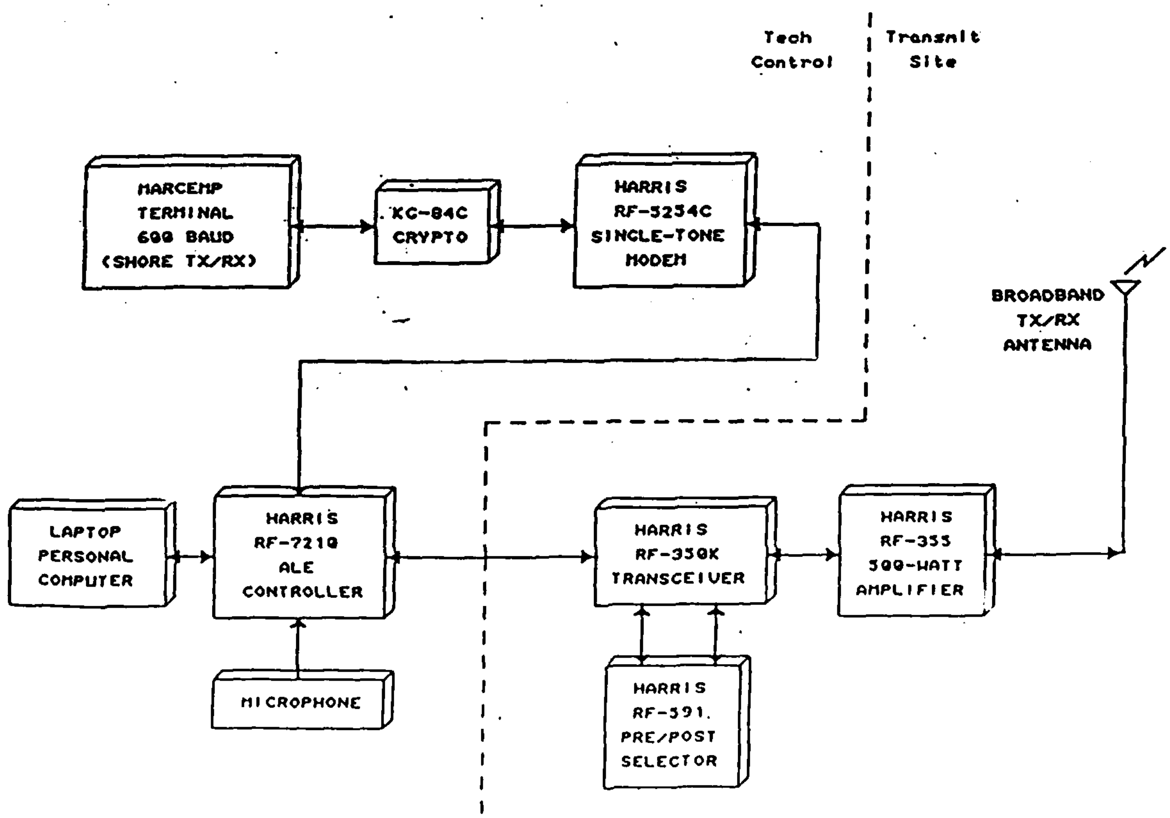
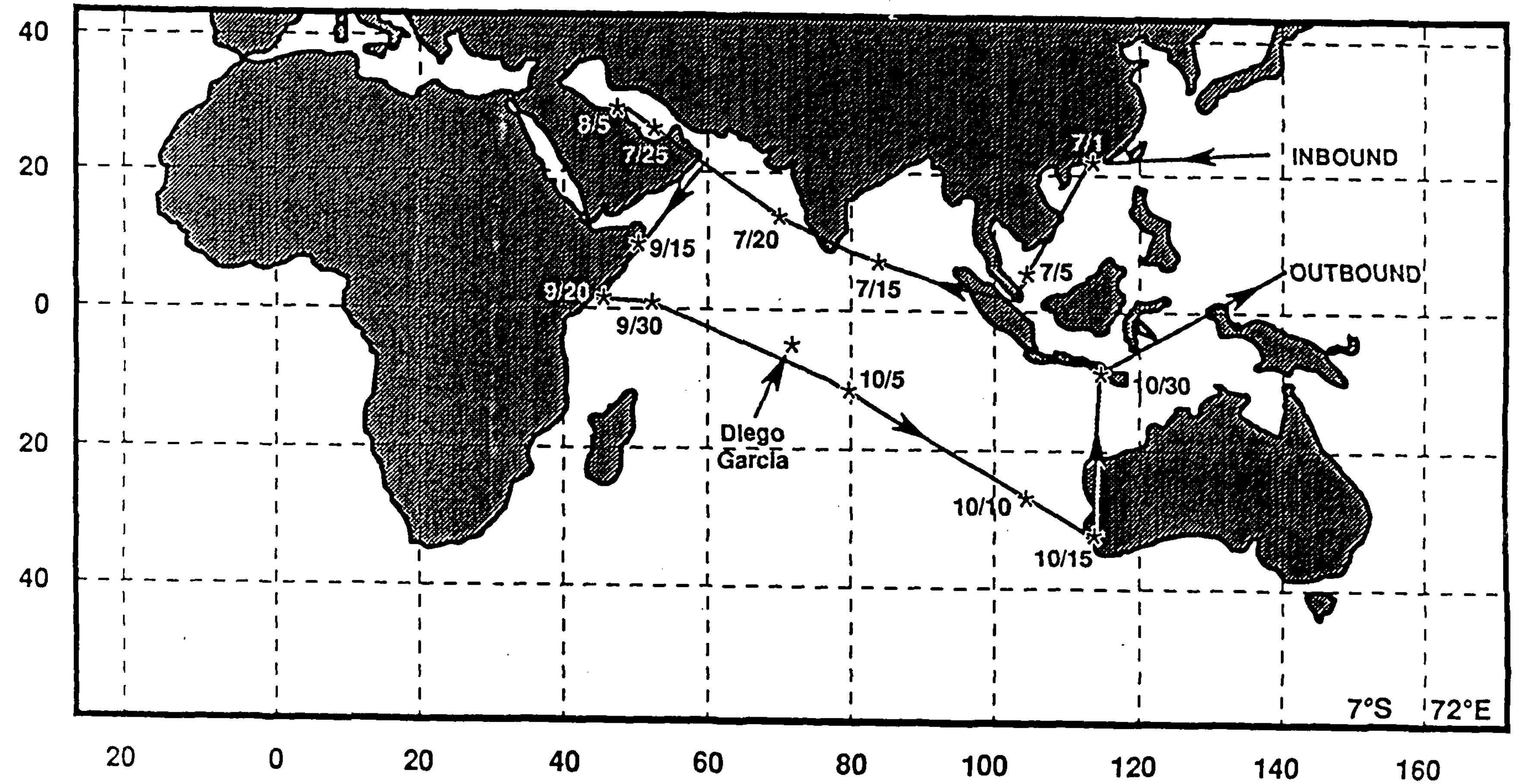


FIGURE 2. SHORE SITE HF ALE SYSTEM BLOCK DIAGRAM

FIGURE 3

Approximate Track of USS Tarawa, Indian Ocean and Persian Gulf

1992 WESTPAC Deployment



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